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Design of an Internet of Things Based One to One Replacement Smart Switch

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***Abstract*—Internet of Things (IoT) conceptualizes the idea of remotely connecting and monitoring real world objects (things) through the Internet. When it comes to our house, this concept can be aptly incorporated to make it smarter, safer and automated. This paper focuses on building a smart switch which can be replaced by the existing manual switches(actuators) which controls (turns ON/OFF) all the electrical appliances in the house. The leverage obtained by preferring this smart switch over the existing manual switches is that the electrical appliances can be controlled remotely by the user on his phone from any distance connected to the internet via WIFI connected microcontroller managed system inside said smart switch. Efficient use of electricity and peace of mind of the consumer or owner is achieved by using the said smart switch. The said microcontroller used in the current prototype is the Arduino micro with ESP8266 WIFI module making use of which all the electrical appliances inside the home can be controlled and managed.**

Keywords—Arduino, Home Automation, IEEE 802.11x, Internet, Internet of Things (IoT), Smart Home

I. INTRODUCTION

With the development of IOT (internet of things), the concept of smart device has become more and more popular. Devices are connected to the internet and stretch their reach. Mobile phone is not the only common smart device. Smart watch, smart rings, smart TV, smart air monitor, smart sensors, all kinds of traditional devices turn to smart and have the capability to access the internet. This contributes to the promotion of wireless home automation. Since home appliances can become smart, the home or the work area can be a smart area with easy automation control. The smart switch elaborated in this paper can provide a unified interface for users to interact with the home appliances.

In this paper, we present a prototype of a smart switch which can be replaced with the existing manual switches without any changes in the electric switch board or the wiring of the house. The smart switches available in the market are highly expensive and require special expertise for installation. Moreover, they require replacement of the existing electric switch board and wiring of the house. The present prototype is a low-cost device and doesn't require any special knowledge or skill for installation.

The next section briefly introduces the architecture of the proposed smart switch and basic system components will be described. The communication interface is illustrated in section III. Section IV and section V presents the implementation of the system, including the hardware and software design respectively. Conclusions are drawn in section VI.

II. ARCHITECTURE

The IoT based smart switch presented in this paper consists of two parts:-

- Master Switch
- General Switch

The part of the smart switch which acts as the brain and controls all the switching of electrical appliances is the master switch. The user will be communicating with this master switch, to control the ON/OFF switching of the electrical appliances, through the BLYNK app.

When the user send the signal to turn ON/OFF the appliance, the signal is received by the master switch, connected to WIFI, through cloud. The master switch then send the control signal to the general switch which then depending upon the signal does the desired switching.

The architecture of the master switch and the general switch are explained in the next paragraphs. The basic architecture of the smart switch is shown in Fig. 1.

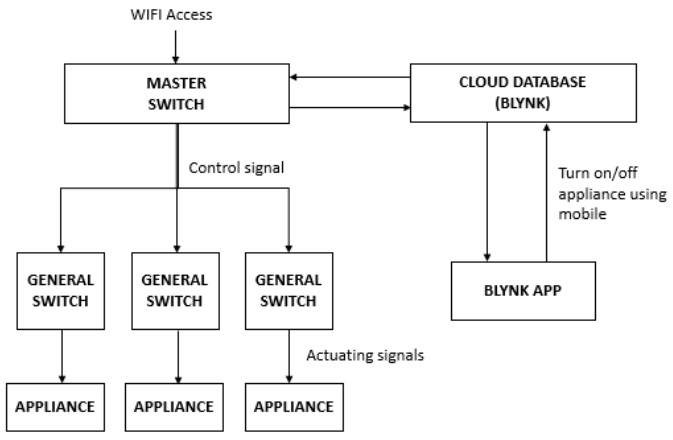


Fig. 1. Architecture of the smart switch

A. Master switch

The master switch is the central control system which gives command signals to the general switches. It consists of:

- Buck converter 12V
- Arduino micro
- ESP8266-12E

The master switch receives 230V AC supply and is converted to 12V DC by buck converter. The Arduino micro uses this 12V DC to operate. The ESP8266-12E WIFI module is connected with Arduino micro which accesses the cloud database of the BLYNK app.

The Arduino micro can control 10 general switches at simultaneously. However, in this paper only three general switches are shown for simplicity. The architecture of the master switch is shown in Fig. 2.

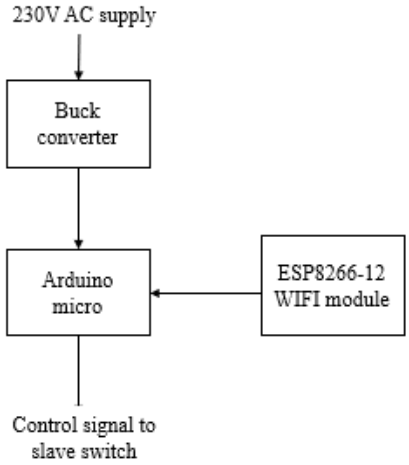


Fig. 2. Architecture of master switch

B. General Switch

The general switch consists of:

- 12V transformer less power supply
- 12V DC electromagnetic relay

The main component of the general switch is relay which gets signal to actuate from the master switch. The power needed by relay to operate is provided by the transformer less power supply. Depending upon the signal received from the master switch the relay either cuts off the 230V supply, turning off the electrical appliance or lets the 230V supply through, turning on the electrical appliance.

The architecture of the general switch is shown in Fig. 3.

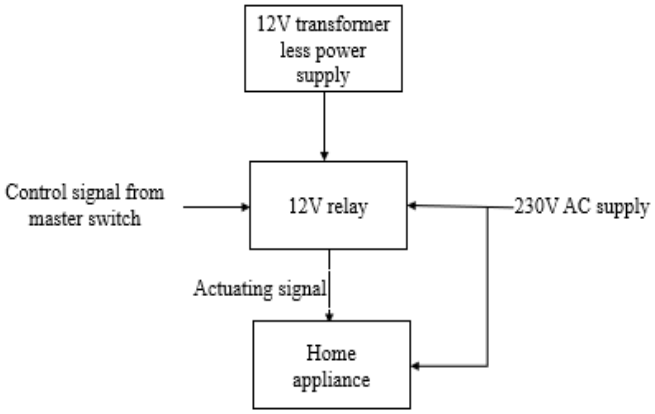


Fig. 3. Architecture of general switch

III. COMMUNICATION INTERFACE

A. Major components of Blynk platform

All the interaction between the electrical appliances and the user is done using Blynk app. Blynk is an Internet-of-Things platform designed to make development and implementation of smart IoT devices quick and easy. It can be used to read, store, and visualize sensor data and control hardware remotely. It is a platform with iOS and android apps to control Arduino, Raspberry Pi and the likes over the Internet. It's a digital dashboard where one can build a graphic interface for the projects by simply dragging and dropping widgets. Both the Blynk server and Blynk library are open source, while the Blynk app is available free for iOS and Android.

The three major components of Blynk platform are: -

- **Blynk App** - allows the user to virtually communicate with electrical appliances using various widgets.
- **Blynk Server** - responsible for all the communications between the smartphone and hardware. It's open-source, could easily handle thousands of devices and can even be launched on a Raspberry Pi.
- **Blynk Libraries** - for all the popular hardware platforms (here Arduino micro) - enable communication with the server and process all the incoming and outcoming commands.

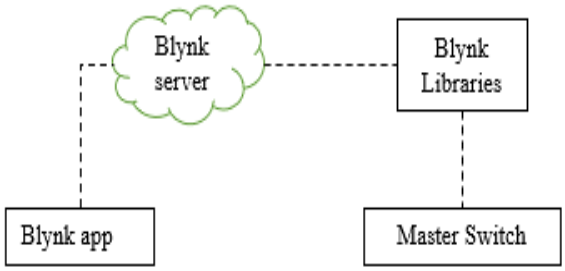


Fig. 4. Major platform of Blynk platform

The block diagram of the Blynk platform is shown in Fig. 4. The user can turn ON/OFF the electrical appliance using the virtual buttons in Blynk app, provided the user's mobile is connected to internet. Here, the master switch has ESP8266-12E WIFI module which is connected to the home internet. So, the Arduino micro can access the data from the cloud and give signals to the appropriate general switch which then turns ON/OFF the desired electrical appliance.

B. Advantages

One of the major advantages of using the Blynk app is the microcontroller, here, Arduino Micro doesn't need to be programmed for each electrical appliance, the app has inbuilt feature to set the desired pins of the microcontroller for each electrical appliance. Other are, it is easy and simple to use with nice Graphic User Interface (GUI). It is feature rich and have an active community of developers. Also, no additional hardware is required. So, it is a tailor fit for our smart switch.

IV. HARDWARE IMPLEMENTATION

The smart switch described in the paper consists of actually two switches, the master switch and the general switch. Also, a single master switch can control ten general switches i.e. ten electrical appliances. So, considering an electric switch board with eleven normal switches, when replace with smart switch, will consist of one master switch and ten general switches.

The installation of the smart switch is just like that of a normal switch and does not require any special skill or knowledge. The IoT based switches presently available require knowledge and they usually come in module. So, all of the electrical circuitry needs to be redone. Also, the cost of these switches is high. But the smart switch described in this paper is around ₹300(one master switch and one general switch). The cost of master switch is ₹250 and that of general switch is ₹50. So, its inexpensive and robust as compared to the ones available in the market.

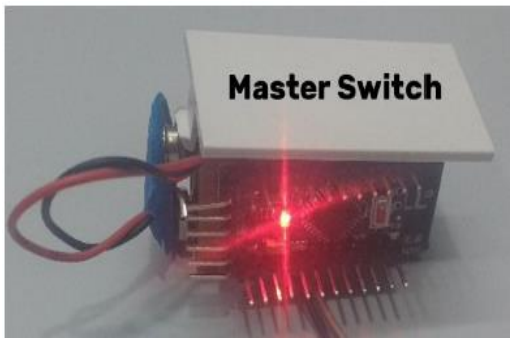
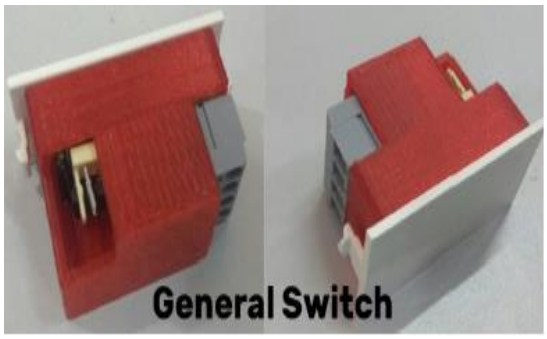


Fig. 5. Master switch



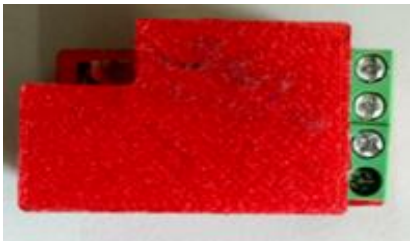


Fig. 6. general switch with bottom side and top view

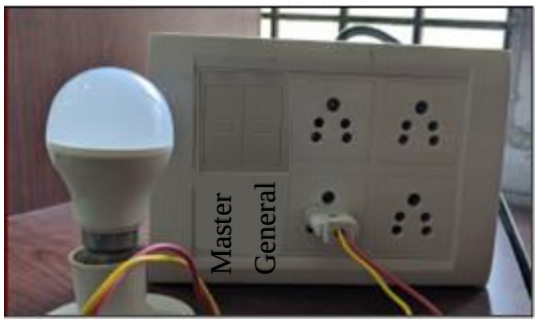


Fig. 7. Smart switch implementation

The master switch and the general switch as shown in fig. 5. and fig. 6. have the exact same dimensions of a normal manual switch. The printed circuit board design (PCB) has been custom made to house all the electronic circuitry within the dimensions of the normal switch. This makes the smart switch easily replaceable with the normal manual switch without any modifications in the switch board or the electrical wiring. The practical implementation of the smart switch is shown in fig. 7.

V. SOFTWARE IMPLEMENTATION

The software implementation of the smart switch involves setting up of the Blynk app and connecting microcontroller i.e. Arduino micro to the Blynk server. The microcontroller can access the Blynk server using a unique authentication token provided by the app. So, it is completely secure communication interface. After both these setups the user just need to enter the default user account and he is ready to control all the electrical appliances using the smartphone.

A. Setup of Blynk app

First, after downloading the app, a new Blynk account is created. An account is needed to save the projects and have access to them from multiple devices from anywhere. It's also a security measure. Then, after successfully logging into the account, start by creating a project. After this, hardware needs to be chosen from the list of supported hardware. Here the hardware is Arduino Micro. After choosing the hardware an authentication(auth) Token will be generated. Auth Token is a unique identifier which is needed to connect your hardware to your smartphone. Every new project created will have its own Auth Token. Auth Token automatically send to email after project creation. Now a new project will be created. The new project has blank canvas so widgets, here we are using only buttons are drag and drop on the canvas. The most important parameter to set is PIN. The list of pins reflects physical pins defined by the hardware. Say, if the LED is connected to Digital Pin 8 - then select D8 (D - stands for Digital). So, for each general switch a dedicated pin in master switch is allotted. Now, the project is ready to run and control all the electrical appliances.

For each master switch the project in Blynk app is to be custom designed depending upon the general switches. Therefore, for multiple master switches the required project can be easily toggled in the app. The workflow of the Blynk app is shown in Fig. 8.

So, for the end user, there will be a default account. All he needs to do is select the right project with the correct number of general switch and he is good to go. The Blynk app for three

general switches is shown in fig. 8. The user can see that that the bulb is on while the fan and the light is off. If the user desires to turn ON/OFF any of the three, then he can simply do it by a touch of a button.

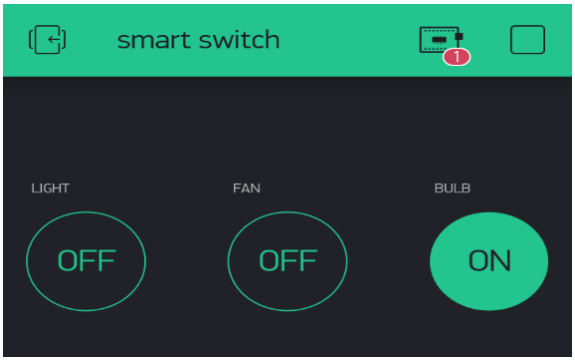


Fig. 8. Blynk app

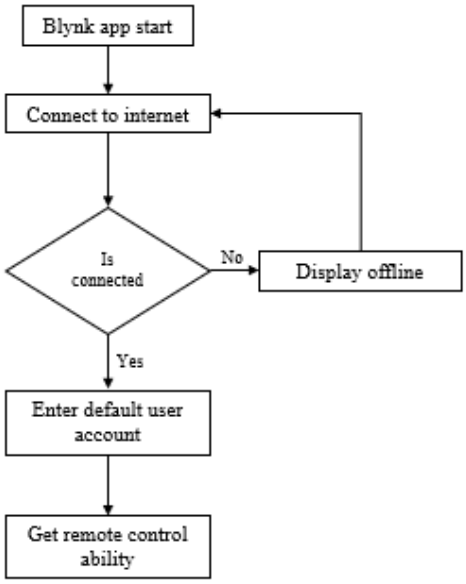


Fig. 9. Work flow of Blynk app

B. Setup of Arduino Micro

For setting up the Arduino Micro, the Blynk libraries are installed in the Arduino software. For connecting to WIFI a simple piece of code is written for ESP8266. The connection to the Blynk Server is done using the Authentication token send by the app. By simple copying and pasting this token in Arduino code we can control our whole setup. The code for Arduino is given in [11].

VI. CONCLUSION

In this paper, we proposed an inexpensive and robust one to one replacement smart switch based on IoT. The smart switch replaces the regular normal switch without any modifications in the electric switch board or the electrical wiring of the house. uses Blynk app which is open source and available for both android and iOS for free. The Authentication token required makes the whole setup highly secure and safe. The user has peace of mind as he can remotely access all the electrical appliances. Also, energy if used more efficiently as the user knows what appliances are working at all times. The products available in market are highly expensive and requires special skill for installation. However, the proposed smart switch is low cost and doesn't require any special skill. Hence, this proposed smart switch is much better and reliable then the existing ones.

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